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first waveguide and said second waveguide, and wherein said first waveguide and said second waveguide have different effective indices of refraction resulting in a first mode of light and a second mode of light being divided unequally between said first waveguide and said second waveguide.

16 ~~56~~. (amended) The device according to claim 15 ~~55~~, wherein the first mode of light is primarily confined to said first waveguide and the second mode of light is primarily confined to said second waveguide.

REMARKS

Claims 41-67 are pending. Claims 41-67 stand rejected under 35 U.S.C. § 103(a) as allegedly being obvious over U.S. Patent No. 6,167,073 (Botez et al.) and U.S. Patent No. 5,721,750 (Kwon et al.). Claims 41-67 have also been rejected under the doctrine of non-statutory double patenting over claims 1-17 of U.S. Patent No. 6,381,380 (Forrest et al.).

Applicants' undersigned attorney respectfully requests reconsideration in light of the above-listed amendments and the following comments.

Non-Statutory Double Patenting Rejection

Applicants' undersigned attorney submits herewith a terminal disclaimer that obviates the double-patenting rejection. Reconsideration of the obviousness-type double patenting rejection is respectfully requested.

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Rejections Under 35 U.S.C § 103(a)

The Claimed Invention

"Photonic integrated circuits (PIC) provide an integrated platform increasingly used to form complex optical circuits. The PIC technology allows many optical devices, both active and passive, to be integrated on a single substrate. For example, PICs may comprise integrated lasers, integrated receivers, waveguides, detectors, semiconductor optical amplifiers (SOA), and other active and passive semiconductor optical devices. Such monolithic integration of active and passive devices in PICs provides an effective integrated technology platform for use in optical communications." (Application, p. 1, ll. 12-19.)

"A particularly versatile PIC platform technology is the integrated twin waveguide (TG) structure in which active and passive waveguides are combined in a vertical directional coupler geometry using evanescent field coupling." (Application, p. 2, ll. 1-3.) Applicants have noted, however, that a "common problem in prior-art TG structures is the relative inability to control the lasing threshold current and coupling to the passive waveguide as a consequence of the sensitivity to variations in the device structure itself. The sensitivity variations arise from the interaction between the even and the odd modes of propagation in the conventional TG structure. This interaction leads to constructive and destructive interference in the laser cavity, which affects the threshold current, modal gain, coupling efficiency and output coupling parameters of the device." (Application, p. 2, ll. 13-19.)

Applicants have addressed these limitations in the art by providing an **asymmetric** twin waveguide (ATG) structure that significantly reduces the negative effects of modal interference in a PIC. The effective index of a passive waveguide is "varied from that of a symmetric twin waveguide such that one mode of the even and odd modes of propagation is primarily confined to the passive waveguide and the other to the active waveguide. As a

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result, the mode with the larger confinement factor in the active waveguide experiences higher gain and becomes dominant." (Application, p. 2, ll. 9-13.) The passive waveguide operates to move the amplified light between the active devices of the PIC. (see Application, p. 2, ll. 18-19.)

Thus, Applicants have disclosed a PIC comprising discrete waveguide devices wherein the modes of light propagating in the PIC are distributed unequally between the waveguide devices. The unequal distribution of light allows for each devices to operate efficiently, without substantial degradation due to modal interference.

Accordingly, Applicants' claim 41 is directed to a monolithically integrated device having at least a first mode of light and a second mode of light propagating therein. The claimed device comprises "a first waveguide; and a second waveguide coupled to said first waveguide, **said second waveguide having a lateral taper formed therein for guiding light between said first waveguide and said second waveguide; wherein the first mode of light and the second mode of light are divided unequally between said first waveguide and said second waveguide**." Similarly, claim 55 is directed to photonic device comprising "at least a first waveguide and a second waveguide, **wherein one of said first waveguide and said second waveguide comprise a lateral taper for guiding light between said first waveguide and said second waveguide, and wherein said first waveguide and said second waveguide have different effective indices of refraction resulting in a first mode of light and a second mode of light being divided unequally between said first waveguide and said second waveguide**." In order to anticipate or render the claimed device obvious, the cited references (Kwon et al. and Botez et al.) must teach the emphasized combination of elements, including dividing modes of light unequally between a first and second waveguide.

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Applicants respectfully submit that the cited references do not teach these claimed combination of elements.

Differences Between the Claimed Invention and Cited References

Kwon et al. disclose a rooftop reflector for decreasing the escape of light from an active device in a twin waveguide structure. (Kwon et al, Col. 5, ll. 15-45.) According to Kwon et al., the rooftop reflector traps light in the laser cavity and allegedly lowers the threshold of the laser. The remainder of the structure disclosed by Kwon et al. is a standard symmetric twin waveguide structure coupling an active device, i.e. a laser, to a passive waveguide.

The Examiner alleges that Kwon et al. at column 4 and in Figure 5 of their disclosure teach dividing even and odd modes unequally between active and passive regions. Applicants respectfully disagree. Figure 5 and column 4 illustrate active and passive devices being combined in a **single** structure. Kwon et al. further disclose that the active and passive devices may be constructed with various different compositions by varying the molarity, dopant, and thicknesses of the layers. Applicants respectfully assert, however, that varying the compositions of composite layers is not equivalent to dividing modes unequally between devices. A device may be constructed of various different compositions and still remain symmetric. Indeed, the only embodiment disclosed by Kwon et al., that of Table 1, is a symmetric device. Thus, Kwon et al. do not teach varying the symmetric characteristic of their exemplary embodiment. Kown et al. simply do not disclose a first waveguide and a second waveguide having different effective indices of refraction. Likewise, Kwon et al. do not disclose the concept of dividing modes of light unevenly between discrete devices on a

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PIC. Kwon et al. do not even mention the concept of asymmetry, let alone asymmetry between a first waveguide and a second waveguide in a PIC.

In contrast, Applicants' claims 41 and 55 are directed to a device comprising a first waveguide and a second waveguide, wherein one of the first or second waveguides have a lateral taper formed therein for guiding light between the first and second waveguide, and wherein **a first mode of light and a second mode of light are divided unequally between said first waveguide and said second waveguide**. Kwon et al. entirely fail to teach dividing a first mode and a second mode unequally between the first and second waveguides, as required by claims 41 and 55.

Indeed, Kwon et al. teach a standard symmetric twin waveguide device, which would be subject to the problems, such as destructive interference between modes of light, that Applicants' invention addresses. Thus, not only do Kwon et al. not teach claimed elements of Applicants' claimed invention, but by disclosing a structure that is subject to the inefficiencies that Applicants' invention overcomes, they actually teach away from it.

Botez et al. disclose a high power laser that employs asymmetry in an antiguiding structure to allow for mode expansion. In high power lasers, mode expansion is critical to the reduction of catastrophic mirror damage resulting from an excessively high power concentration at the laser facet. The antiguiding structure is directed at expanding the optical mode without paying a penalty in laser efficiency and while reducing the eventuality of mirror damage. Botez et al. teach using asymmetry within the laser cavity to achieve these results.

Specifically, Botez et al. teach that the laser is comprised of "a substrate, an active region, and confinement and cladding layers on each side of the active region to surround the active region. At least one structure at which light emission primarily occurs and inter-

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element regions are formed adjacent to the core element. The core element has a selected effective refractive index for the emitted light and the effective refractive index of the inter-element regions is higher than that of the core active region. The optical confinement and cladding layers on opposite sides of the active region have different indexes of refraction to provide an optical waveguiding structure in the transverse direction in the core element which is asymmetrical and which favors lasing only in the transverse fundamental optical mode." (Col. 3, ll. 19-34.)

Thus, Botez et al. teach antiguiding in a **single** laser device that uses asymmetry **within** the device. The laser comprises several different layers, but all of the layers are part of the **same** laser device. Botez et al. do not disclose combining the laser with another device, such as a waveguide and using tightly bound guided modes to transport light to and from the laser. Accordingly, Botez et al. could not possibly disclose or even suggest dividing modes of light unequally between the laser and a separate passive device that operates to move light to and from the laser.

Therefore, while Botez et al. teach a single active waveguide device, they do not teach a second waveguide having a lateral taper formed therein for guiding light between said first waveguide and said second waveguide, wherein the first mode of light and the second mode of light are divided unequally between said first and said second waveguide as required by claims 41 and 55. Indeed, while Botez et al. teach using asymmetry within a single laser device, they do not teach, or even suggest, dividing modes of light unequally between two independent devices or having two separate waveguide devices with different effective indices of refraction. Accordingly, Botez et al. entirely fail to teach claimed elements of Applicants' invention.

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Thus, Kwon et al. and Botez et al. fail to teach claimed elements of Applicants' invention. Furthermore, neither reference even mentions the limitations in the art that Applicants' invention addresses, and certainly neither suggests Applicants' claimed improvements. For these reasons, Applicants respectfully request withdrawal of the rejection under 35 U.S.C. § 103(a).

CONCLUSION

For all the foregoing reasons, Applicants respectfully submit that the present application is in condition for allowance.

Respectfully submitted,

Date: 4/28/03

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In accordance with 37 C.F.R. § 1.121, below is a marked up copy of amended claims 55 and 56:

55. (amended) A photonic device comprising:

at least a first waveguide and a second waveguide, wherein one of said first waveguide and said second waveguide comprise a lateral taper for guiding light between said first waveguide and said second waveguide, and wherein said first waveguide and said second waveguide have different effective indices of refraction resulting in a first mode of light and a second mode of light being divided unequally between said first waveguide and said second waveguide.

56. (amended) The device according to claim 55, [wherein at least a first mode of light and a second mode of light propagate in said device, and] wherein the first mode of light is primarily confined to said first waveguide and the second mode of light is primarily confined to said second waveguide.

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